COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	Politehnica University of Bucharest
1.2 Faculty	Faculty of Electronics, Telecommunications and Information Technology
1.3 Department	Applied Electronics and Information Engineering Department
1.4 Domain of studies	Electronic Engineering, Telecommunications and Informational Technologies
1.5 Cycle of studies	License
1.6 Program of studies/Qualification	Applied Electronics (ELA)

2. Course identification information

2.1 Name of the course				**3D Graphics**			
2.2 Lecturer				S.l. Dr. Ing. George Valentin Stoica			
2.3 Instructor for practical activities				S.l. Dr. Ing. George Valentin Stoica S.l. Dr. Ing. Cristina Elena Stoica			
2.4 Year of studies	IV	2.5 Semester	I	2.6 Evaluation type	Test	2.7 Course choice type	Mandatory

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week, out of which	2	3.2 course	2	3.3 practical activities	2
3.4 Total hours in the curricula, out of which	56	3.5 course	28	3.6 practical activities	28
Distribution of time					hours
Study according to the manual, course support, bibliography and hand notes					25
Supplemental documentation (library, electronic access resources, in the field, etc)					10
Preparation for practical activities, homework, essays, portfolios, etc.					10
Tutoring					0
Examinations					3
Other activities					0

3.7 Total hours of individual study	48
3.9 Total hours per semester	104

3. 10 Number of ECTS credit points	4

4. Prerequisites (if applicable)

4.1 curricular	Computer programming Data structures and algorithms Object-Oriented Programming Algebra and geometry
4.2 competence-based	General programming, object oriented programming, C/C++/C#/Java programming languages

5. Requisites (if applicable)

5.1 for running the course	Not applicable
5.2 for running of the applications	Compulsory attendance at laboratories (under UPB regulation).

6. Specific competences

Professional competences	C6. Development of simple computing applications, application design.
Transversal competences	CT3 Adapting new technologies, personal and proffesional development using printed documents, specialised software, electronic documents.

7. Course objectives (as implied by the grid of specific competences)

7.1 General objective of the course	The course's objective consists in a good understanding of the base concepts and specific techniques regarding the computer graphics domain. The course presents the aspects of the three-dimensional geometrical transformations, of the transformations ranging from object modeling to image generation on the computer's display. The course continues with the advanced techniques for image generation and high realistic graphical applications: shading, lighting, natural phenomena, anti-aliasing, texturing. The applications have the purpose to practice the concepts learned during the courses. The experiments are based on development of graphical applications using different technologies: either using OpenGL graphical library combined with C++ language and GLUT toolkit, either using Java and Java3D technologies. The students could experiment the all the concepts presented during the courses
4.2 Specific objectives	By graduating this course the students will learn the computer graphic's basic and advanced concepts. These concepts combined with the practical applications allow students to develop complete solutions for

	computer graphic based applications: graphical applications, virtual reality applications, etc. Students also could develop techniques and methods for modeling, generation and visualization of 3D objects and complex scenes

8. Content

8.1 Lectures	Teaching techniques	Remarks
Introduction to 3D graphics 1.1. Preview of the 3D graphic domain 1.2. The components of a 3D generation system	Teaching is based on using the projector (covering communication function and demonstration), oral communication methods such as expository and questioning methods. Course materials are lecture notes and presentations, suggested problems. (All materials are available electronically through the course website	1 hours
Graphical libraries. OpenGL 2.1. Reference systems, coordinate systems, color systems 2.2. The OpenGL graphical library. The GLUT toolkit 2.3. The OpenGL's components. Basic operations. Basic objects.		3 hours
Object modeling 3.1. Modeling techniques 3.2. Polygonal model: polygon representation, polyhedron representation, polygonal model implementation		4 hours
Geometric transformations 4.1. Vector based operations 4.2. Three-dimensional geometric transformations 4.3. Three-dimensional primitive transformations: translation, rotations, scaling 4.4. Homogenous coordinate		4 hours

system. Transformation definitions 4.5. Geometric transformations composition. Inverse Transformations. Reference systems changing 4.6. Modeling transformations		
Viewing systems 5.1. Viewing systems definition 5.2. Viewing transformation 5.3. Projection transformation: parallel projection, perspective projection 5.4. Normalized coordinate system 5.5. 3D screen coordinate transformation 5.6. Rasterization: line generation, polygon generation		4 hours
Optimization techniques 6.1. Object Clipping: the definition of clipping, two-dimensional clipping. „Sutherland-Hodgman" clipping method. Viewing volume clipping 6.2. Hidden-surface removal: hidden-surface removal in object space, hidden-surface removal in object space - Z-buffer algorithm, culling, hidden coplanar surfaces		4 hours
Reflection and lighting models 7.1. Theoretical aspects of light reflection. Phong reflection model		2 hours

7.2. Shading models. Gouraud shading model. Phong shading model. 7.2. Natural phenomena generation		
Anti-aliasing 8.1. Theoretical aspects of aliasing 8.2. Anti-aliasing techniques		2 hours
Texture mapping 9.1. Texture mapping 9.2. Texture filtering		2 hours
Verification evaluation		**2** hours

Bibliography

1. Felicia Ionescu, Grafica in Realitatea Virtuala, Editura Tehnica, Bucuresti 2000.
2. A. Watt, 3D Computer Graphics, Addison-Wesley, 1992.
3. OpenGL, GLUT: http://www.opengl.org/documentation/.
4. Java 3D: http://java.sun.com/products/java-media/3D/
5. Felicia Ionescu, Valentin Stoica: 3D Computer Graphics Laboratory Guidelines
6. Course web site http://141.85.107.254/G3D/

8.2 Practical applications	Teaching techniques	Remarks
Graphical libraries: OpenGL	The course's Web site contains the laboratory's book along with a brief description regarding each application session. During the application sessions will be practiced the theoretical aspects presented by the courses. Will be used different development technologies: Visual Studio Console applications, OpenGL graphical library, the GLUT toolkit, Java and Java 3D API. It is required for the students to study the laboratory's guidelines prior attending to	4 hours
Object modeling		4 hours
Viewing systems		4 hours
Reflection and lighting models		4 hours
Texture mapping		4 hours
Virtual scenes modeling and rendering 1		4 hours
Final evaluation		4 hours

	the application sessions for an efficiently time usage.	

Bibliography

7. Felicia Ionescu, Grafica in Realitatea Virtuala, Editura Tehnica, Bucuresti 2000.
8. A. Watt, 3D Computer Graphics, Addison-Wesley, 1992.
9. OpenGL, GLUT: http://www.opengl.org/documentation/.
10. Java 3D: http://java.sun.com/products/java-media/3D/
11. Felicia Ionescu, Valentin Stoica: 3D Computer Graphics Laboratory Guidelines
12. Course web site http://141.85.107.254/G3D/

9. Bridging the course content with the expectations of the epistemic community representatives, professional associations and employers representatives for the domain of the program

Computer graphics is a technology that has changed and continues to change the approach in many practical applications such industry, medicine, education, research, arts and entertainment.
The graphics using calculation allows the generation of images from three-dimensional models of objects that make up the virtual scene. Two performance requirements of graphics systems are vital: realism and generate the images in real time. These requirements involve both software issues, the selection of the most appropriate algorithms for image generation and hardware issues, achievement of modern equipment to ensure realism and speed of generating images in 3D graphics. Multiprocessor Workstations and implementing hardware graphics accelerators imager algorithms are based on virtual reality equipment and technological developments have allowed the use of a huge number of virtual reality applications , available now for various categories the user .
Computer graphics has a multitude of applications: making user interfaces developed in many utilities and programming environments, computer-aided design (CAD - Computer Aided Design), graphical presentations, interactive scientific data visualization, multimedia technology.
The course combines theoretical aspects and implementation of graphics image generation three-dimensional virtual objects and scenes. In the early hours are presented basic operations in computer graphics: modeling three-dimensional objects, geometric transformations in space visualization systems, raster transformation. It also presents advanced aspects of image generation three-dimensional (anti -aliasing, shading, texturing), both from a theoretical perspective and the approach in programming. Resume the practice of all these aspects of image generation in terms of programming, using graphics library OpenGL, GLUT and system development in virtual reality modeling language VRML.
After completing this course, students are learning the basics and the advanced three-dimensional graphics. This knowledge combined with laboratory applications covering gives the opportunity to develop complete applications for three-dimensional graphics, virtual reality, or, more generally, a wide range of graphics applications.

Also , students will be able to develop techniques and methods for modeling , generation , three-dimensional visualization of objects or scenes

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final mark
10.4 Lectures	-Knowledge of fundamental theoretical concepts; - Knowledge of the application of theory to specific problems; - Differential analysis techniques and theoretical methods.	Tests with equal marks during the semester, the topics cover the whole field, providing a synthesis of comparative theoretical material, covering and explaining the exercises and problems of application patterns.	60%
10.5 Practical applications	- Knowledge of commonly used Internet programming technologies and their practical application.	Final examination laboratory - comprehensive practice when a component is assessed by verifying the implementation, testing and operation regarding specific practical problems in 3D graphics programming.	40%
10.6 Minimal performance standard			
C4 Project implementation using software components			

Date Lecturer Instructor for practical activities

…… S.l. Dr. Ing. George Valentin Stoica S.l. Dr. Ing. Cristina Elena Stoica

S.l. Dr. Ing. George Valentin Stoica

Date of department approval Director of Department,

……. Prof. Dr. Ing. Sever Paşca